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British, French, and Chinese Nuclear Forces: Implications for Arms Control and Nonproliferation

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PROJECT ON RETHINKING ARMS CONTROL

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Introduction

The purpose of this paper is to report on the research findings contained in Volume V of the *Nuclear Weapons Databook* series, published in March 1994, and to examine the arms control implications of British, French, and Chinese nuclear arsenals and policies.[1]

Although the geopolitical situation has changed drastically in recent years, none of the five acknowledged nuclear powers has decided to dismantle its nuclear arsenal. For one reason or another, all five have decided that continued possession of nuclear weapons will remain a part of their security policies. In fact, in all five countries, modernization programs proceed, albeit in limited ways.

The book examines the past, present, and projected future nuclear arsenals of Great Britain, France, and China. As with the four earlier volumes of the *Databook* series, we have been as comprehensive as possible and have documented our information with primary sources, whenever possible. The volume has 437 pages, 2,600 footnotes, 200 photographs, 6 maps, 54 tables, and 3 appendices providing an in-depth description of each nation's nuclear testing program. After a brief introductory chapter, two chapters are devoted to each country's nuclear program. The first of the two chapters describes the history of why and how each nation obtained the bomb and provides an overview of the production complex where warheads and bombs are developed, tested, and manufactured. The second of the two chapters describes, in great detail, each nation's nuclear forces and capabilities, specifically the development and deployment of the many types of aircraft, missiles, submarines, and other weapon systems. There are 53 fact sheets describing the various weapon systems, 16 for the British, 25 for the French, and 12 for the Chinese.

The volume fills an important void in the extensive literature about nuclear weapons. As with the previous four volumes, we asked hard questions and have done our best to supply the answers. We have tried to answer such questions as these: How many nuclear weapons are there? Where are they deployed or located? What do they look like? Where and how are they made? How much do they cost? How are they transported, maintained, and guarded? What plans are there for using them? What command, control, and

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[1] Robert S. Norris, Andrew S. Burrows, Richard W. Fieldhouse, *Nuclear Weapons Databook, Volume V: British, French, and Chinese Nuclear Weapons* (Boulder, CO: Westview Press, Inc., 1994).

communications infrastructure supports them? The motto of the *Databook* project has been that "no detail is too small." Our experience has demonstrated that while a fact may seem trivial one day, on another day it may contribute to resolving an important debate, or allowing the understanding of an interesting issue.

While perhaps obvious, it must be emphasized that undertaking research on nuclear weapons and nuclear history is a more challenging scholarly endeavor than writing about the American labor movement, the Battle of Waterloo, or the history of architecture. As General John M. Shalikashvili told Congress on April 1, 1993, "a country's nuclear secrets are probably its most prized possessions."[2] Nuclear weapons have had, and continue to have, a mystique about them that has caused officials in all five declared nuclear weapons states to divulge as little information as possible within the traditions of each society.

Preparation of the volume had its own set of problems. Unlike the first four volumes, which relied heavily on information collected, analyzed, and made public by the U.S. government, the information in this volume, to the extent possible, is drawn from primary documents in Britain, France, and China. Each country presented unique challenges as we tried to acquire authoritative and official information about its nuclear arsenal.

While our knowledge of each nation's experience with nuclear weapons deepened, we realized that we were unintentionally creating an analytical approach that may permit comparative perspectives about many aspects of nuclear weapons. The comparative approach, while quite common as a social science tool, has been underutilized in nuclear studies because of the extreme secrecy that has always surrounded these issues. The approach will need much further development and refinement. But even the blunt tool we have fashioned here may assist in the analysis of some future trends.

For example, understanding the history and origins of nuclear weapons in these three countries may offer some insight into the long-term problems of proliferation and disarmament. In what ways are the factors that shaped the decisions of the 1940s and 1950s—when Britain, France, and China chose to develop the bomb—different from those of the 1990s, when other countries may decide to develop the bomb and stockpile an arsenal? How difficult has it been, and how difficult will it be, for a nation to develop a nuclear weapon? Writers on proliferation seem to be divided into two schools: the minimalists, who tend to believe that it is relatively easy to develop a nuclear weapon, and

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[2] U.S. Congress, House, *Department of Defense Appropriations of FY 1994 Part 1*, Hearing before the Appropriations Committee, 103d Congress, 1st Session, April 1993, p. 260.

the maximalists, who tend to believe that it is relatively hard. It is interesting that both camps use the recent case of Iraq as evidence. The minimalists argued that there are few secrets to making a bomb and what cannot be achieved domestically can be bought, legally or illegally, on the world market. At the end of the Gulf War, many analysts were surprised at how much Iraq had been able to accomplish. Had the war not occurred, the minimalists say, and had there not been the intrusive U.N. inspections, Iraq may have been on the verge of becoming a nuclear power in the early 1990s. The maximalists looked at the same situation and concluded that the Iraqis still had a long way to go, expended enormous resources, and produced a haphazard program that probably would have had great difficulty delivering a usable and reliable weapon.

Close study of the British, French, and Chinese experiences (as well as that of the United States and the Soviet Union) from the 1940s to the early 1960s places us in the maximalist camp. An examination of the five successful attempts, about which there is some record, demonstrates that building a bomb has been a difficult and expensive task not attained without the large-scale mobilization of vast sectors of the society. To be successful in developing the bomb, a nation needs a certain level of technological competence, a broad enough base of scientists, engineers, and technicians, and a lot of money.

Why have the leaders of these nations decided that they need nuclear weapons? Generally, it was because they believed that possession of them provided some measure of security against foes near and far. The dynamics of the Cold War created the basic pretext for each of the five powers' decision to obtain the bomb. Secondary rationales were often advanced about how the bomb could be influential in the conduct of certain foreign policy situations. The possession of nuclear weapons once conferred "great power" status on a nation, and perhaps not coincidentally, the five permanent members of the U.N. Security Council are also the five acknowledged nuclear powers.

As we enter the sixth decade of the nuclear era, we seem to be at a crossroads. The justifications once offered for possessing nuclear weapons by the big five are less salient, while at the same time many other nations seem interested in obtaining nuclear weapons for the supposed benefits they are said to bring.

The experiences of the big five may or may not influence the decisions made by other nations in this new era. Without the "stability" of the Cold War, is it less likely or more likely that other nations will want the bomb? How difficult will it be to obtain a nuclear arsenal and maintain it? What are the political, social, financial, and environmental costs associated with traversing the nuclear path? Many unintended consequences occurred as a result of building a nuclear arsenal. They were either not recognized in the frenzied climate of the Cold War or purposely ignored; but many of them are now in full view. The very serious environmental situation at the Department of Energy (DOE) facilities, where U.S. nuclear weapons were made, finally became a major policy issue in the late 1980s. It could take up to a trillion dollars, according to one DOE official's estimate, and several decades to clean it up, if it can be cleaned up at all. The health of those who worked at the plants—who were exposed during nuclear tests, or were the subjects of some grotesque experiments—is still at issue. The extent and gravity of these problems in the former Soviet Union is even worse than in the United States. This unanticipated legacy that was part and parcel with building bombs should give any future power pause before traveling down the nuclear path.

To what degree has there been collaboration and assistance in developing the bomb? Or, to put it another way, to what degree were the five nations' efforts independent? What might their experiences mean for future nuclear powers? One notable finding was that there has been more collaboration between nations than I had realized. Proliferation started early and has been a constant in the history of nuclear weapons developments. Before Pearl Harbor, the British and Americans were exchanging information, and after 1943, they became intimate partners in the Manhattan Project. After the war, for many reasons, there was a falling out; but from 1958 to today, the British and Americans have forged an extremely close relationship on nuclear matters. One of the major findings of the book is that this relationship has been perhaps the single most important factor in determining the kinds of nuclear programs the British have pursued and the numbers of warheads they have built.

The French were probably the most independent of the three and consequently took a longer time to achieve all of the milestones. U.S. collaboration with the French during the Manhattan Project was marginal, though France did obtain some limited information about materials' production. There were not any French scientists at Los Alamos during the war, and for a long time afterward the Americans viewed the tumultuous politics of the Fourth Republic (with its visible and influential French Communist Party) with suspicion. There were basing agreements under NATO; U.S. nuclear weapons were supplied to French forces; and U.S. nuclear units were based in France and its territories (Morocco, for example). But a relationship of the kind that developed with the British never came to pass.

In the Chinese-Soviet case, there remain many interesting questions. The conventional account, promoted by the Chinese, suggests that Beijing's split with Moscow in 1959-1960 gave an impetus to Chinese self-sufficiency. To argue the opposing case, the Russians apparently supplied the Chinese with the blueprints of the major facilities that were needed to make a bomb. These included a gaseous diffusion plant, plutonium production reactors, chemical separation facilities, and others. Without more extensive documentation from the Chinese and the Russians, it is difficult to tell at this point which argument has greater weight. Certainly the Russians gave the Chinese a head start in nuclear weapon development and saved them much time. The nature of the collaboration, at least for the short time it went on, was extensive and unprecedented. In the new Russia, perhaps some of the archives associated with this period can be opened and examined.

Though beyond the scope of the book, other instances can be cited. While some general facts are known about these, an exploration of the detailed ways in which one country helps another would prove interesting.

In what ways has Israel benefitted from French and/or American help?

In what ways did Israel help South Africa with its bomb?

In what ways has India had help from the United States, the USSR, and Canada?

In what ways has China helped Pakistan; in what ways is it helping Iran?

In what ways did the Soviet Union help North Korea?

In the end, the historical record may well suggest that defining proliferation may be in the eye of the beholder: one person's proliferation may be another's security alliance.

Nuclear Weapons Programs: A Synopsis

Great Britain

In the British case, we concluded that they have produced about 800 warheads of eight types over a 40-year period, including those exploded in tests. The book has the first published pictures of several types of British bombs—the Red Beard, Yellow Sun, and WE-177. The stockpile has remained fairly steady from the 1960s through the late 1980s, in the 300 to 350 range. With recent retirements and reductions, it is now around 200 weapons, and even with the Vanguard/Trident II program, due for completion around the turn of the century, the British stockpile will only return to about 300 weapons.

An important point needs to be made here about the British and French forces. There is a lingering perception in some people's minds that the British and French stockpiles are scheduled to double, triple, or quadruple in the near future. That was potentially true in the mid-1980s when there were plans to modernize and to expand their arsenals. Under some MIRVing (multiple-independently targetable reentry vehicles) schemes, combined with optimistic Ministry of Defense scenarios and healthy projected budgets, the numbers did go up dramatically. But these plans did not come to pass. There was never quite enough money, and in the past few years, never quite enough need as the end of the Cold War undermined the rationale for a massive expansion. Weapon system programs were cancelled outright, cut back, or stretched out.

A further consequence of the lingering impression was the thought that with the lesser powers' nuclear arsenals growing, and the U.S.-Russian arsenals shrinking, at some point they would converge, so much so that perhaps there could be arms talks among all the powers. As plans now stand, this closure will not happen. Even after all of the U.S. and Russian reductions, and all of the British, French, and Chinese modernizations, the combined arsenals of the big powers will be 10 to 15 times larger than the combined arsenals of the smaller powers. The exact ratios rest on decisions not yet made or announced. For example, the United States could easily have 6,000 to 8,000 nuclear weapons and the Russian arsenal equal numbers or probably more.

An important and interesting finding about the British is that they have had a supplementary stockpile of American nuclear weapons that at times has exceeded their own. Since 1958 these have included four types of gravity bombs, two kinds of nuclear depth charges, three types of missiles, two calibers of artillery shells, and two types of atomic land mines. The warheads have been deployed in the United Kingdom and more numerously with Royal Air Force and British Army-of-the-Rhine units in Germany. At the peak in the late 1970s, there were almost 400 warheads. Today there are zero. In September 1991 President Bush announced that all artillery shells, Lance missile warheads, and tactical naval weapons would be withdrawn. On 2 July 1992 the Pentagon announced that all U.S. warheads of these types had been returned to the United States.

As noted above, it has been the "special relationship" with the United States that has fundamentally shaped British nuclear practices and policies. It is the reason why there have been so few British nuclear tests: 24 since 1962 at the Nevada Test Site have been done in very close conjunction with their U.S. counterparts. British warhead designs are thought to be almost direct copies of American ones and thus do not need a full testing program. The supplementary American stockpile substituted for a British one that London once contemplated building in the late 1950s.

France

For the French, we concluded that they have produced over 1,100 warheads of 9 different types, including over 200 for explosive tests. As in the British case, there will be no dramatic quantitative increase in the French stockpile. In fact, we estimate that after attaining a peak of around 540 in the early 1990s, the number will drop to some 465 warheads at the end of the century. French weapons exist in greater variety than the British, with silo-based ballistic missiles, nuclear-powered ballistic missile submarines (SSBNs) and submarine-launched ballistic missiles (SLBMs), aircraft, and even battlefield systems.

In general we know much more about the details of the French weapons and program than the particulars of the British history and forces. As in the American case, we have French warhead designations and some details about their weights and yields, etc. We know a great deal about the testing program: in many cases we know the tests and warheads that went together. At the end of 1993, the French stated the precise number of tests: 192 plus 12 safety tests for a total of 204. But there is still much to be known. The French have not produced an official history, even of the early years. We are not sure of how they got the H-bomb, or who should be credited with its patrimony. Not very much is known about the research laboratories, the Centre d'Études Atomique (CEA), where French warheads are designed and produced. The CEA is a powerful bureaucracy in French society and for the most part likes to conduct its business out of public view.

The manner by which France decided to actually build the bomb was not the result of a single decision, nor was it a clear-cut, long-range policy rationally planned and executed. The decision was taken without any public knowledge or parliamentary debate on the potential military implications of atomic energy. As in the United States, the Soviet Union, and Great Britain, a small group of scientists, in collaboration with military and government officials, brought the bomb program to fruition. For many years the CEA and other agencies operated without clear-cut official sanctions to build the bomb, yet the small cadre progressed relentlessly toward the goal.

If one had to pinpoint a date as the official beginning of the bomb's development in France, it might be the end of 1954. On 26 December 1954, Prime Minister Pierre Mendès-France met with his Cabinet and other officials to discuss the merits of building the bomb. The outcome of that meeting was the establishment of a secret program to accelerate the development of the bomb.

Over the next three years, many steps—some small, some large—contributed to the momentum. With the creation of the Fifth Republic in late 1958, there was both continuity with the past and a marked acceleration of the bomb program. Though many of the same personalities occupied important positions, they were now led by the dominant personality of Charles de Gaulle, serving in the powerful office of President, the result of his own handiwork. De Gaulle had always felt that nuclear weapons were essential for French independence and had kept himself abreast of the secret program throughout the previous decade. Far more so than with other leaders, de Gaulle and Gaullism are closely associated with nuclear weapons. For de Gaulle, French possession of the bomb symbolized independence and a greater role in European and geopolitical affairs. Without a French bomb, de Gaulle felt that the superpowers would carry on their dialogue, taking little notice of the smaller nations.

There was no "special relationship" between France and the United States. There was very little French involvement in the Manhattan Project. Charles de Gaulle's stamp on the nuclear program and the *force de frappe* were enormous from 1946 until he stepped down in 1968. While the afterglow continued, it is now on very low wattage.

However much the stereotype is promoted that the French have had an independent nuclear posture, there has been quiet—sometimes highly secret—cooperation in nuclear matters between the United States and France. While it is generally true that France developed the first generation of its *force de frappe* without outside help, the United States has increasingly aided France in the development of more advanced missile and warhead designs.

Almost without exception, French nuclear pioneers in the 1950s and 1960s faced steady political opposition from the United States. The disagreement was to a large extent brought about by the incompatibility between French nuclear aspirations and U.S. policies against nuclear weapons proliferation. Both Presidents Kennedy and Johnson were opposed to nuclear collaboration with France—they banned the export of ballistic missile technology to France and blocked exports of crucial inertial guidance equipment. According to a recently declassified report by the Stanford Research Institute, U.S. nonproliferation policy during the 1960s sought to check the spread of nuclear weapons, in part by attempting to persuade France to shed its nuclear aspirations. The United States "constantly *thwarted* France's nuclear ambitions. . . . *In spite of* U.S. efforts, the French continued their nuclear program."[3]

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[3] Stanford Research Institute (SRI) (Wynfred Joshua), *New Perspectives in U.S.-French Nuclear Relations* (partially declassified and released under the FOIA), Research Memorandum SSC-RM-8974-2,

After de Gaulle's passing, there was greater involvement with the Americans. An unprecedented level of nuclear collaboration between France and the United States began in 1972, although for 13 years it would not be formalized in any new agreement or amendment. By the early 1970s, elements of the government of President Georges Pompidou became more receptive to the idea of nuclear cooperation with the United States. President Richard Nixon and National Security Adviser Henry Kissinger realized that the French, through their own efforts, had developed and deployed nuclear forces and were bound to continue the expansion and improvement of their capabilities. Hence the policy of active U.S. opposition, while having limited effect in the early years, had become completely meaningless. Moreover, in contrast to their predecessors, Nixon and Kissinger appreciated the contribution French forces made to Western security.

Five years ago there was an important article by Professor Richard Ullman published in *Foreign Policy*.[4] Ullman looked at this issue in great detail and conducted more than 100 interviews with top-level French and U.S. officials. He found that through winks, head shakes, silences, and the like, U.S. experts would guide their French counterparts down the right path toward the solution of a problem without technically transferring the forbidden restricted data on the design of nuclear weapons. Very few people knew of these meetings and conversations. Typically, Ullman recounts, a request would come from the Champs-Élysées to the White House for specific categories of information. In this *Databook* volume, we review Ullman's points and have added some other details not previously revealed, mainly derived from the Stanford Research Institute study.

What did the United States get out of this relationship? Its "shopping list" included such concrete measures as guaranteed access to French ports and airfields, and air and surface lines of communication during time of war; guaranteed availability of the Petroleum, Oils, and Lubricants (POL) system; and guaranteed arrangements for overflight rights and the use of air bases in northeastern France. A more realistic and important objective was an improved political climate that would permit the strengthening of Franco-American political ties that in the long run would lead to greater French cooperation with NATO. Some of the specific concessions included increased coordination of French conventional forces with NATO, coordination of French tactical nuclear weapons with NATO, and an exchange of strategic targeting information. In a less formal way, the United States took advantage of

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August 1972, pp. 65-66, emphasis added.

[4] Richard Ullman, "The Covert French Connection," *Foreign Policy*, no. 75 (Summer 1989), pp. 3-33.

the French atmospheric testing program from 1966 to 1974. Special bases were constructed in New Zealand (Project Longbank), Fiji, and Easter Island to study the various effects of nuclear explosions. France provided the estimated time of each test, and special U.S. planes were flown out of Pago Pago to gather information. U.S. ships were also used for these missions.

In this volume, we examine in some detail the warhead production complex. We describe the activities at the six Centre d'Études. We examine the special facilities where the five nuclear materials used for nuclear warheads must be produced or concentrated. These are the fissionable materials—uranium-235, and plutonium-239—and the thermonuclear materials—tritium, deuterium, and lithium-6 (the sixth material used, U-238, is abundant in nature).

Unlike the United States, there is no distinct separation between the civilian and military nuclear spheres in France: some gas-cooled, graphite-moderated reactors built for generating electricity have also produced materials for nuclear weapons. And we specify, for the first time, that we believe that Bugey-1, Chinon 2 and 3, and possibly St. Laurent 1 and 2, Chinon 1 and the Spanish reactor Vandellos 1, have contributed to the French weapons program. We describe at length the French testing program, first in Algeria and then in the Pacific.

China

We estimate that China maintains nuclear forces of about 450 weapons of two basic categories. There is a deployed force of some 300 "strategic" weapons structured in a "triad" of land-based missiles, bombers, and submarine-launched missiles. There also may be some 150 artillery shells and atomic demolition munitions, but these may have been retired. There are probably some additional spares over and beyond the deployed force. Thus, the total would put China ahead of Britain, but slightly behind France, making it the fourth largest nuclear weapons state in the world.

The most formidable of China's nuclear forces consist of ballistic missiles. With ranges varying from about 1,700 to 13,000 kilometers, the great majority can only strike Asian targets. Only four deployed missiles have intercontinental range and can reach targets in North America. As of the end of 1993, all Chinese ballistic missiles carried only one warhead each. It is unclear whether China plans to deploy missiles with multiple-reentry vehicles (MRV) or MIRV capabilities, although such research has been undertaken. Several tests in 1985 and at least one missile test in 1986 reportedly were related to developing these capabilities, and the Chinese leadership has publicly praised the successful results. Some Western publications already credit China with MIRVed missiles, though this conclusion seems to be in error.

China also maintains a nuclear bomber force of approximately 150 aircraft of two types. In addition, China has an unknown number (probably well over 30) of nuclear-configured and -capable attack aircraft. China's nuclear gravity/free-fall bombs, both fission and fusion, are estimated to number about 150. China is developing a new supersonic bomber scheduled for future deployment.

The third and most recent leg of China's triad is the small force of submarine-launched ballistic missiles carried aboard nuclear-powered ballistic missile submarines. Deployment of the force has been slow because of technical difficulties in developing solid fuel for the missiles and nuclear reactors for the submarines. Two submarines are operational and armed with 12 missiles each, and more vessels are under construction. It appears doubtful that China will produce a large SSBN force because of the cost, but it has been reported that a new class of submarines and a new SLBM are in research and development. It seems unlikely that the future fleet would number more than four to six ballistic missile submarines.

There is considerable uncertainty about the numbers and kinds of Chinese tactical nuclear weapons. Very little is said in the open literature about them, and Chinese officials have been absolutely silent on the matter. Several tests of low-yield warheads (one perhaps a neutron bomb) and field training exercises (that simulated tactical nuclear weapon use) suggest that China may have forces and weapons for tactical nuclear missions. In 1976 the U.S. Defense Intelligence Agency (DIA) reported that atomic demolition munitions (ADMs) "may be used" by China. The revised DIA report in 1984 noted that China "may be considering the feasibility of supplementing its strategic nuclear arsenal with tactical nuclear weapons." China appears to have embarked on the development of distinctly tactical nuclear weapon systems, such as short-range missiles and artillery, but the evidence is very sketchy, and it is impossible to pinpoint the types or numbers. Several weapon systems, such as short-range ballistic missiles and attack aircraft with nuclear bombs, can be used in tactical nuclear roles if China so chooses. With the easing of tensions between the former Soviet Union and China, the potential for combat across their common borders has been considerably reduced, and with it possibly the need for tactical or battlefield nuclear weapons.

Given its limited resources, and a policy of limiting the number of tests, China has tried to extract the greatest amount of information from each of the 39 tests that are known to have taken place. We estimate that six nuclear warhead designs have been tested and deployed.

As with Britain and France, in the *Databook* volume we trace the origins of China's nuclear weapons program and the decision to build the bomb. The decision is very much bound up with the founding of the People's Republic of China (PRC) itself, the determination of Mao Zedong, and the aspiration that China should be a major world power, sovereign and independent, well armed and a leader of the Communist world. Early in its history, the PRC viewed the United States—conspicuously armed with nuclear weapons and supporting the nationalist Kuomintang on Taiwan—as its chief adversary. This perception was reinforced by the fact that the United States did consider using nuclear weapons against China on several occasions during and after the Korean War and even deployed nuclear-armed B-29 bombers to Guam in 1951 for possible use against targets in China. The United States also deployed nuclear-capable weapon systems (with nuclear warheads) on Taiwan in the 1950s and early 1960s. Thus China had every reason to fear the threat of U.S. nuclear weapons.

The decision to build a bomb was made by Mao in consultation with a close circle of advisers, on 15 January 1955. The bomb was an extraordinarily ambitious enterprise for a new nation, especially given the severe lack of adequately trained Chinese scientists and engineers and the total inexperience of the Chinese government with nuclear technology, not to mention the shortage of money and equipment. China started its nuclear weapons quest with a blank slate and empty pockets.

Ironically, many of China's top scientists and engineers who led the nuclear weapons program were educated and trained in the West, particularly at U.S. universities and research facilities. In the 1950s, the Chinese government led a successful campaign to entice these Western-trained expatriates to return to China to work on the bomb program.

Despite much talk of self-reliance, China undertook its nuclear weapons program with tremendous assistance from the Soviet Union. The Soviet Union basically designed and built the fledgling nuclear industry in China until 1960, when the USSR ceased abruptly. The book describes this cooperation in which the most remarkable aspect was the agreement by Moscow to supply a finished bomb to the Chinese. This never came to pass, as the Soviet Union withdrew its assistance and went home by mid-August 1960. More than 30 years later, a host of questions remain unanswered about the nuclear-sharing decision of Khrushchev and Mao. Why did Khrushchev agree to it in the first place? Precisely what kinds of knowledge and technology were provided to the Chinese? Is the experience of developing the bomb an anomaly in the way science is conducted in the PRC?

Similar to the efforts of the other nuclear powers, the Chinese project to build the bomb was characterized by the large-scale mobilization of manpower and resources. However, unlike the other nuclear powers, China began its nuclear weapons program with the approach that all tasks should be pursued simultaneously—a crash program designed to master nuclear and thermonuclear weapons' theory, technology, design, and construction in the shortest time possible. This was in addition to a similar effort to produce the missiles and aircraft that would carry the nuclear weapons.

In the *Databook* volume, we review a very complicated bureaucratic structure that has overseen the nuclear weapons program, and we describe—in more detail than has hitherto been available—the major facilities and sites where the weapons are developed, produced, and tested.

The research, development, and testing of Chinese nuclear weapons is the responsibility of the Chinese Academy of Engineering Physics (CAEP), also called the Ninth Academy. The CAEP is composed of about a dozen institutes that carry out different tasks and contribute to the overall bomb program. Unlike the giant U.S. national laboratories at Los Alamos and Livermore, where almost everything is concentrated under one roof, the CAEP institutes are located in several places and are more compartmentalized than their American counterparts. The CAEP Director is now Hu Side, who replaced Hu Renfu. The institutes are numbered 901, 902, 903, etc., but for reasons unknown there is no number 908. Their precise names, responsibilities, and locations are not publicly known. All of the CAEP institutes are concentrated in and around Mianyang (Sichuan), with the exception of 907, which is in the province of Jiangsu, north of Shanghai. Institute 905, outside Mianyang, is the Chinese Sandia, the ordnance engineering laboratory where the non-nuclear parts of a nuclear weapon are designed.

Further, we describe the little known "Third Line" facilities in this volume. The Third Line facilities comprise an entirely separate and more modern complete nuclear fuel cycle infrastructure for nuclear weapons than the one built initially with Soviet help. Between 1964 and the mid- to late-1970s, China carried out a massive construction program, in effect building a duplicate industrial base in the remote regions of China to serve as a strategic reserve in the event of war, initially foreseen with the United States and later with the Soviet Union. This project encompassed mining, energy production, railways, hydroelectric power, steel factories, and machine building. Many of the new sites were concentrated in the western and southwestern provinces of Sichuan, Yunnan, Guizhou, Gansu, Ningxia, and Qinghai, as well as parts of Shaanxi, Henan, Hubei, and Hunan, away from the more vulnerable coastal cities and provinces. In general, the Chinese tried to use the topography for protection, building in narrow valleys or near mountains. The scale of the undertaking was enormous, much larger than Roosevelt's New Deal or Stalin's Five-Year Plans. By general estimation, it probably had a negative impact on China's economic development. The Third Line was accomplished in great secrecy, and even today it is not well known or discussed.

The overall effort had a strong military bias. Not surprisingly, Mao decided to build a duplicate set of nuclear production facilities as well. The facilities were built fairly rapidly from the mid-1960s to the early 1970s and were concentrated in Sichuan at sites intended to reduce their vulnerability from attack. The first nuclear production facilities were all built with Soviet help, fairly near the Soviet border, and were highly visible and vulnerable to air or missile strikes. The more southern Third Line facilities, it was thought, would require much greater penetration of Chinese air space and air defenses and therefore would be less vulnerable.

Despite tremendous difficulties, a second plutonium production capability was built, including China's largest plutonium production reactor and chemical separation plant in Guangyuan and a nuclear fuel component plant in Yibin, both in Sichuan Province. The two plutonium production reactors at Jiuquan/Subei and Guangyuan constitute China's only plutonium sources for nuclear weapons. Each is estimated to produce about 300 to 400 kilograms per year. It is believed that the Guangyuan complex has replaced Jiuquan as China's main plutonium production and nuclear weapons assembly facility. With steady rates of production, the two reactors *could* have produced around 15 tons of plutonium. This is many times what would be needed for a modest stockpile of some 450 warheads, and thus the amount of plutonium allocated for weapons is probably smaller. Other evidence that there is a surplus is the fact that, according to informed sources, China stopped producing plutonium for weapons in 1991.

The Third Line gaseous diffusion plant was built at Heping (*Chin-k'ou-ho*), also in Sichuan, with a capacity of up to 20 times that of the original Lanzhou plant. It is unclear exactly when it became fully operational, but it was probably around 1975. The DIA estimated in 1972 that Heping would be capable of producing 750 to 2,950 kilograms of HEU U-235 per year, far larger than the 150 to 330 kilograms per year at Lanzhou. As with plutonium production, the theoretical upper limit could be anywhere from 17 to 60 tons, but the small stockpile size probably would only require a fraction of that amount.

The future of Chinese forces is the most speculative of the three. There have been some recent newspaper articles suggesting that the forces will expand, but no empirical proof is offered to support this. We do not know whether they plan to MIRV their missiles or how large the SSBN program will be. Actually there are counter examples of Chinese nuclear forces remaining steady or undergoing denuclearization. One report describes replacing nuclear warheads with conventional warheads on some DF-21 intermediate-range ballistic missiles (IRBMs).[5] A second example that remains to be confirmed may be the retirement of the tactical nuclear stockpile. It is popular these days to look to China as the Cold War replacement of the Soviet Union and suggest that the Chinese have expansionist desires in Southeast Asia.

Americans have an unfortunate tendency to mirror image what it has done onto other nations. To suggest that China might have a security policy based on different principles is sometimes hard to incorporate into our analyses.

Some Concluding Thoughts on Proliferation and Arms Control

In closing, several points should be underscored about the proliferation lessons and arms control implications of the experiences of these three second-tier powers. As noted above, characteristic of Britain, France, and China was a large-scale industrial effort to make the bomb in the first place. And in addition, there was a substantial investrnent to research, develop, and deploy sophisticated delivery platforms, such as bombers, ballistic missiles, and nuclear-powered submarines. A future nuclear aspirant need not set such high goals for itself. Future third-tier nuclear nations may take many short cuts and design much more modest programs. The maximalist paradigm may be an historical relic. To take one example, it has been estimated that a team of scientists using the calculators of the 1940s would take five years to solve what it takes a Cray computer one second to perform today.[6] Components that once had to be developed from scratch now can be purchased, smuggled, or stolen. A minimalist effort may result in a few fairly crude bombs with simple delivery

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[5] "China Switches IRBMs to Conventional Role," *Jane's Defense Weekly*, 29 January 1994, p. 1.

[6] Department of Energy, *The Need for Supercomputers in Nuclear Weapons Design*, January 1986, p. 11.

vehicles. Arsenals of even several hundred nuclear weapons may be a thing of the past. Third-tier powers may build a handful or a couple dozen bombs. Obviously the prospects for proliferation are greater if the minimalist paradigm is true.

For many years there have been suggestions that the five declared nuclear nations might participate in arms control negotiations. While there are examples of the five negotiating on certain topics, such as the Comprehensive Test Ban talks that are now going on in Geneva, I see little likelihood of the five powers talking about some sort of quantitative reductions. The differences in the size of the arsenals between the first and second tiers will remain very large, and there are no incentives that can entice Britain, France, and China to cut further than they already have.

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